attention also to the bearing such considerations have on the attempts which are occasionally made after minute correlations and identifications of individual beds in such a group of strata. The example set in this matter in the present work is excellent, for a clear distinction is drawn between those limestones or other beds about whose continuity there can be no question, and those whose occurrence is local; but example may be usefully enforced by precept.

The same wholesome refusal to draw hard and fast lines where none have been drawn by Nature is seen when we come to the chapter on the Tuedian beds. Special attention is drawn to the fact that, though these can be separated, as far as lithological character goes, from the overlying Bernicians, the line of demarcation is by no means everywhere of the same geological age. The Tuedian beds resemble so closely the "Cement Stone Group" of the central valley of Scotland, that they are doubtless the southern continuation of that subdivision. The Scotch beds, as is well known, were laid down in an assemblage of ponds, creeks, and lagoons separated by banks of sand and muddy shoals. The Tuedians of the north of England do not seem to show quite such rapid changes horizontally as are common in their Scotch equivalents, but they must have been formed under very similar conditions. Beds thoroughly Tuedian in character occur on the west of the Cross Fell Range near Shap: they are very thin, and we are there probably close to the southern boundary of the area over which these peculiar beds were laid down.

Very interesting are the accounts of the somewhat peculiar group of rocks discovered in the deep borings for rock salt alongside the Tees. First came more than 1000 feet of Red Marls and Sandstones, which may be very safely assigned to the Trias. Judging by what is seen at the outcrop, we should have expected the main mass of the Magnesian Limestone to follow; but such was not the case. The hole then entered a group of rocks consisting of gypsum, anhydrite, rock salt, and beds of limestone. Prof. Lebour is of opinion that the Magnesian Limestone was not reached by any of the holes. Hereby several questions may be started. Are the 1000 feet of red marl and sandstones to be assigned to the Red Marl or the Red Sandstone? A nice difficulty for the system-mongers; but before we try to solve it, we may ask whether these two subdivisions are as sharply marked off from each other in Yorkshire and Durham as in other parts of England. There is no reason why they should be; and if they are not, we may well content ourselves with calling the whole Trias. Then how are we to account for the presence of the rock salt and gypsum, which, as far as is known, is never seen along the outcrop, or indeed anywhere else in England? It seems likely that towards the end of the Permian period unequal subsidence produced hereabouts a depression in the bed of the water; that, as now happens elsewhere under similar conditions, the Permian lake became largely laid dry, so that water remained only in this and perhaps other similar basins; and that, from the highly concentrated solutions which remained in these lakelets, local deposits of a strongly chemical character were precipitated. The author remarks on the close resemblance which these deposits bear to the subdivision of the Permian called "Rauchwacke" in Germany, and would apply this name to them. That they and the German "Rauchwacke" were formed under very similar conditions there can be little doubt, but there is no proof that the two were formed at the same time, and this is almost necessarily implied if we give them the same name. In a group of rocks like the Permian, formed in so many distinct basins, and under changing conditions the order and nature of which were probably never the same in any two basins, the minor subdivisions must necessarily be totally different in different areas, and any attempt to correlate these minor subdivisions can be little better than guess-work. If the subdivisions are to have distinctive names, it seems better that the beds of each basin should each have a set of names to itself. Similar objections apply to the habit of designating the subdivisions of the English New Red Sandstone by German names; it is the practice to look upon the New Red Marl as the time-equivalent of the Keuper, and the New Red Sandstone as that of the Bunter, but there is absolutely no proof of this. It is worse when a statement is made that the Muschelkalk is absent in England, and a fictitious unconformity is postulated between the New Red Marl and the New Red Sandstone to account for its absence. Who can say whether the lower part of the New Red Marl, or the upper part of the New Red Sandstone, or both, were not forming here while the Muschelkalk was being deposited in Germany?

The peculiarities of structure exhibited by the Magnesian Limestone are shortly but clearly described. They have been long known, but little has been done towards explaining how they were produced. The problem is one of extreme complexity, but a persevering attack on it, even if it did not lead to a complete solution, would almost certainly throw great light on what we in our ignorance call concretionary action. Sundry structures, formerly referred to this mysterious cause, have been shown to be due to simpler and less recondite processes, but there is a large residuum of cases still awaiting explanation.

We have by no means exhausted all the questions and suggestions which this little book will prompt; but we hope we have said enough to show that it will prove to the attentive reader far more interesting than might at first be supposed. And we may learn from it that in Great Britain, the very motherland of geology proper, ransacked as it has been for now well-nigh a century by the ablest of geologists, there is still many a corner, full of unsolved problems, awaiting the attention of those geologists who cannot wander far from home but are yet anxious to win their spurs.

A. H. GREEN.

PHYSIOLOGICAL PSYCHOLOGY.

Elements of Physiological Psychology. A Treatise on the Activities and Nature of the Mind from the Physical and Experimental Point of View. By George T. Ladd, Professor of Philosophy in Yale University. (London: Longmans, Green, and Co., 1887.)

THE aim of this volume is twofold: first, to give a clear, accurate, and up-to-date account of the psycho-physiology of man; and then to enter a protest against a merely materialistic interpretation of the phenomena. Such a protest, coming from one who is well abreast of modern physiology, is likely to carry weight which could not but be lacking to the opposition of a thorough-going disciple of the "old psychology" school. No one can say that Mr. Ladd's conclusions are reached in and through his ignorance of the real nature and value of the facts on which materialists base their arguments.

The work consists of a short introduction and three parts, of which the first deals with "The Nervous Mechanism," the second with "The Correlations of the Nervous Mechanism and the Mind," and the third with "The Nature of the Mind."

The first part opens with a chapter on the elements of the nervous system, and then proceeds to show how these elements are combined into a systematic whole. The morphology of the nervous mechanism having thus been described, its general physiology is dealt with in the next two chapters, and the automatic and reflex-motor functions of the central mechanism are successively brought under review until, in ascending order, we reach the cerebral hemispheres, the special functions of which are reserved for the second part. The reasons the author gives for adopting this plan are: (1) that nothing is known as to the molecular structure of these hemispheres, or as to their automatic and reflex-motor centres and activities which adds anything of importance to the description of the nervous system as a mechanism or to the mechanical theory of its action; and (2) that the correlations which exist between the structural condition or physiological function of the nervous system and the phenomena of mind are chiefly (if not wholly) capable of study as illustrated in the cerebral hemispheres. An important chapter on the end-organs of the nervous system then follows, and is succeeded by one on development. A concluding chapter in this part is devoted to the mechanical theory of the nervous system, in which, while the author admits that the changes which take place in the brain are essentially the same as those with which the science of molecular physics has elsewhere to deal, he reaches the conclusion that "it cannot be pretended that even a beginning has been made toward a satisfactory theory of the functional activity of the central organs considered as a special case in molecular physics."

In this part, together with much that is familiar, there is not a little that has hitherto seen the light only in scattered publications.

The second part opens with two long chapters on the localization of cerebral functions. The experiments and conclusions of Fritsch and Hitzig, Exner, Ferrier, Munk, Goltz, and others are carefully described and considered. The conclusions to which the author is led by his review of these labours are as follow:—

"Three principles may be laid down as summing up the results reached by inference upon the basis of experiment with respect to the localization of function in the cerebral cortex. The first principle is to be accepted in the form of a general postulate derived from a study of the other parts of the nervous system, and confirmed on attempting to apply it to the cerebral hemispheres. It may be stated as follows: the different elementary parts of the nervous system are all capable of performing its different specific functions when, and only when, they have been brought into the proper connexions and have been exercised in the performance of those functions. This principle includes two important laws which, we know, hold good throughout the nervous mechanism, and which lie at the physical basis of important psychical facts and laws; they are the *law of Specific Energy* and the *law of Habit*. The remaining two of the three principles alluded to above may be said to follow from the first: they are the principle of *localized function* and the principle of *substitution*. The former asserts that, in the normal condition of the nervous system, all parts have not the same definite functions. Everything in both its anatomy and physiology indicates that the principle of localized function does apply, in some sort, to the cerebral hemispheres. So-called 'centres,' however, are in no case to be regarded as portions of the nervous substance that can be marked off by fixed lines for the confinement of definite functions within rigid limits. These areas are somewhat different for different brains of the same species; they widen when a heightened energy is demanded of them; their centres are neither mathematical points nor very minute collections of cells. Nor are these areas perfectly isolated localities; on the contrary, they obviously overlap each other in certain cases. Furthermore, the functions of the cerebrum are not absolutely confined to those centres with which, under ordinary circumstances, they are chiefly or wholly connected; in which, that is to say, they are localized. If such centres, for any reason, become incapacitated or relatively unfitted to perform their normal functions, the same functions may be performed by other areas of the cerebral cortex, provided these areas also stand in the proper connexion. This is the principle of substitution."

In the remaining chapters of the second part we are led to consider sensations in their qualitative and quantitative relations, the nature of "things," or the presentations of sense (which introduces us to "space-form"), and the time-relations of mental phenomena (which introduces us to "time-form"). Then we are conducted, through feeling, to the higher faculties—memory, will, conception—the physiological basis of which is sought in vain. The concluding chapter of this part gives a summary of the general correlations of body and mind. The author seems to intend that two points shall stand out prominently: first, the essentially synthetic activity of the mind in constructing those presentations of sense which we call things or objects; and secondly, notwithstanding a vague correlation, the inconceivability of any physiological basis thereof. "For that spiritual activity which actually *puts together* in consciousness the sensations, psycho-physics cannot even suggest the beginning of a physical explanation." And again: "When we speak of a physical basis of memory, recognition must be made of the complete inability of science to suggest any physical process which can be conceived of as correlated with that peculiar and mysterious *actus* of the mind, connecting its present and its past, which constitutes the essence of memory."

In the third part the conclusion to which especial prominence is given is this: that the subject of all the states of consciousness is a real unit-being, called mind; which is of non-material nature, and acts and develops according to laws of its own, but is specially correlated with certain molecules and masses forming the substance of the brain. The nature of this correlation is considered at length. To speak of mental states and processes as the "product" of the nervous mass of the brain in any sense of the word corresponding to that which we rightly apply to the various secretions of the body, involves us at once, it is held, in the grossest absurdities; while the theory that claims that *all* mental phenomena, whatever their varied characteristic shading, have exact equivalents, as it were, in specific forms of the nerve-commotion of the living brain is marked by its "surprising audacity." "Standing on a slender basis of real fact, it makes a leap into the dark which carries it centuries in advance of where the light of modern research is now clearly shining." The author, however, by no means rejects, he strongly contends for, a causal nexus as existing between brain and mind. He regards the term organ (or instrument) of the mind, as applied to the body, as particularly calculated to emphasize the relation of the ideas and volitions which arise in consciousness to the control of the muscular apparatus. He will have nothing to do with monism, but contends that psycho-physical science, simply observing the facts and building on them, establishes the dualism of brain and mind. "We affirm, then," he says, "that we are entitled to say: The changes of the brain are a *cause* of the states of consciousness; and the mind behaves as it does behave, *because* of the behaviour of the molecules of the brain." "We affirm also that we are equally entitled to say: The states of consciousness are a cause of the molecular condition and changes of the nervous mass of the brain, and through it of the other tissues and organs of the body."

So far, in dealing with the third part, we have perhaps made it appear that, in the author's view, the correlation is complete. And the passages we have quoted seem to justify this view. But many other passages reject such an interpretation with scorn. "In investigating the correlations which undoubtedly exist between the nervous mechanism and the phenomena of consciousness, it is found that some of these phenomena imply activities of the mind which do not admit, in any sense of the word, of being thus correlated." "Judgment itself is a form of mental phenomena for the essential part of which no physical equivalent can be discovered or even conceived of." "To account for this boundless expansion of the activities of consciousness (in the early years of childhood), with its surprising new factors and mysterious grounds of synthesis and assumption, by proposing an hypothesis of 'dynamical associations' among the particles of nervous substance in the brain, is a deification of impotency." . "Not one of the higher acts of feeling, knowing, or willing, so far as its *sui generis* character is concerned, admits of being correlated with, or represented under, any of the conceivable modes of the motion and relation of molecules of nervous substance."

It would seem, then, that the author plays rather fast and loose with this correlation, as indeed is apt to be the fashion with dualists. We doubt whether he is justified in saying that psycho-physical science establishes the dualism of brain and mind. Here, it seems to us, the writer's usual caution forsakes him. Idealism, materialism, occasionalism, dualism, monism, are none of them theories that are in any likelihood of being "established" for many a long day. They are of the nature of *beliefs;* and strong as is his advocacy of the dualistic creed the author falls into error if he dreams of its speedy establishment. We could wish that he had squarely faced the difficulties which the acceptance of the dualistic hypothesis entails, a few of which are but barely mentioned on page 597. These and many others may not be difficulties to him; but surely he who would establish a doctrine should meet half-way such difficulties as are likely to trouble unbelievers. We could wish, too, that he had given us a more detailed criticism of the monistic creed which he rejects. To ask *why* the double-faced unity (the human being) manifests itself both in physical and mental states—"one being, in two wholly incomparable modes of manifestation"—and to say that monism has to undertake the task of showing *how* the one reality can appear under these two phenomenal forms of being—matter and mind—is surely not a very powerful or acute criticism. There are many *hows* and *whys* which can only be answered by quietly pointing to the facts. We do not say that monism can in this way be "established"; but we regard the criticism as weak.

Nor are we impressed with the force of the argument upon which so much stress is laid, that for certain higher mental activities no physiological correlate can be conceived. It seems to us that, if anywhere, the inconceivability comes in at the very beginning. If once the conceivability of a correlation between a nerve-commotion of any kind and a state of consciousness be admitted, there need be no further talk of inconceivability in the matter. *There* lies the rub: elsewhere we only find questions of degree and of relative complexity.

We cannot take leave of this valuable and important work without expressing our sense of its ability, its thoroughness, and its candour. There is no other book in the English language that covers its ground.

C. LL. M.

OUR BOOK SHELF.

The Essentials of Histology. By E. A. Schäfer, F.R.S. Second Edition. (London: Longmans, Green, and Co., 1887.)

THIS edition is, in several respects, an improvement on the first. The volume is less bulky, and there are some useful additions to the text so as to bring this up to date, especially as regards the methods of histological study. There are seventeen valuable illustrations added. The omission in the first edition of references to the authors of the illustrations has, we are glad to see, been corrected in this edition.

On the whole, we think the book a clear exposition of the present state of human histology, and, as such, it will prove useful to students and teachers. E. KLEIN.

Aluminium: its History, Occurrence, Properties, Metallurgy, and Applications, including its Alloys. By Joseph W. Richards. 12mo, pp. 346 (Philadelphia: Band. London: Sampson Low and Co. 1887.)

THIS volume is mainly a compilation based upon the late H. St. Claire Deville's treatise published in 1858, and the newer work by Dr. Mierzinski in Hartleben's "Chemisch-Technische Bibliothek," which appeared in 1883. As no special work on aluminium had previously appeared in English, we agree with the author that no apology is necessary in presenting it. The subject has been systematically treated both from the scientific and